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Structure optimization for enhanced luminescent and paramagnetic properties of hydrophilic nanomaterial based on heterometallic Gd-Re complexes

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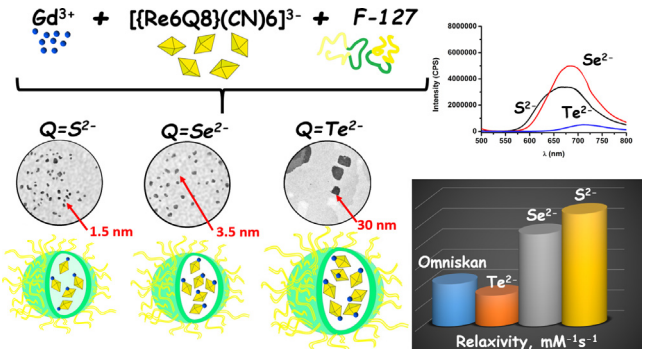
HIGHLIGHTS

- Controlled self-assembly of Gd(III) complexes with clusters $[\{Re_6Q_8\}(CN)_6]^{4-}$ ($Q = S^{2-}$, Se^{2-} or Te^{2-}) into nanoparticles in aqueous solutions.
- Luminescence of cluster units and paramagnetism of Gd(III) ions provide bimodal magnetic-luminescent functions of the nanoparticles.
- Nature of $\{Re_6Q_8\}$ affects crystallinity and size of nanoparticles which tunes their magnetic relaxivity and colloid stability.
- $\{Re_6S_8\}$-based nanoparticles are optimal basis for bimodal contrast agents due to low cytotoxicity, high magnetic relaxivity and luminescence.

GRAPHICAL ABSTRACT



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ABSTRACT

The work introduces facile synthetic route of conversion of Gd(III) complexes with hexanuclear cluster anions $[\{Re_6Q_8\}(CN)_6]^{4-}$ ($Q = S^{2-}$, Se^{2-} or Te^{2-}) into colloidal core-shell nanoparticles, where hard cores are the water insoluble $Gd_x[\{Re_6Q_8\}(CN)_6]_y$ complexes, hydrophilic shells are built from $(PEO)_{100}$-$(PPO)_{65}$-$(PEO)_{100}$ (F-127). The comparative analysis of TEM and PXRD data for the dried colloids in correlation with the colloidal, luminescence and magnetic relaxation properties of the aqueous colloids indicates that the nature of the cluster anions $[\{Re_6Q_8\}(CN)_6]^{4-}$ greatly affects the size and crystallinity of the hard cores, which in turn influences both magnetic relaxivity and luminescence of the corresponding aqueous colloids. The analysis of the results revealed hydrophilic colloids based on $Gd_x[\{Re_6S_8\}(CN)_6]_y$ as the best ones from the viewpoint of the functional properties, which along with the low cytotoxicity makes them very promising basis for further application as contrast agents in both MRI and luminescent imaging.

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